

Review on Amphibious House

Tejas Urkude¹, Amarchand Kumar², Apoorva Upadhye³, Madhura Padwal⁴

^{1,2,3,4}Final Year B.E. Student, Dept. of Civil Engineering, D. Y. Patil College of Engineering, Akurdi, Pune, Maharashtra, India

Abstract – Floods are the sources of massive scale destruction from the early stages of civilization. Due to increase in the population growth and urbanization which leads to deforestations and a high percentage of the paved surface which blocks the infiltration of water in case of precipitation. Flood is a natural process which cannot be ceased or restrict to occur, thus efficient flood preparation is the need of the time to minimize the damage in flood prone areas. In view of these problems, there are different techniques which prevent the flood destruction in urban areas and low land areas too. Through these techniques, people can face with flood rather than fighting with nature. The study concluded the new idea of the Amphibious House which basically targets the concept of flood resistant house in low land areas. It provides safe shelter to the people living in the house. This concept is based on the principle of Buoyancy. The amphibious architecture helps in allowing water to flow rather than creating obstruction. Approaching this concept helps in planning and recognizing the beneficial aspects of seasonal and occasional flooding. It means that allowing not only to live with water, but to expand with it. The study also reviewed the methodology used for this idea which is based on buoyancy. It is found that, the first International Conference on Amphibious Architecture, Design and Engineering, ICAADE 2015, was held in Bangkok, Thailand in August 2015. The second ICAADE 2017 was held at the University of Waterloo in Canada in June 2017.

Key Words: Amphibious house, buoyancy, flood-proof, architecture, flood mitigation, retrofitting, ferrocement, hybrid structure, polystyrene.

1. INTRODUCTION

We know that due to climate changes and global warming advances, level of sea rises gradually, which leads to heavy rain, severe hurricanes tsunami, flooding and other natural disasters. Therefore there is need to adopt effective countermeasure against these disasters especially flooding. Regarding this, concept of Amphibious House has been adopted here, in which it refers to structures that will function both in land and water in response to flood in low lying areas. This configuration allows the houses to rise with the floodwater, mitigating the damage caused by the seasonal flooding.

However, this concept is not new to world but still not introduced in our country "India". In this, basically buildings

are made for land but same buildings become floating house for water. The idea of Amphibious House gives experiences of living in both water and land. In engineering languages, It can be said as hybrid structure, in which the weight of a structure is partially supported by both land and water simultaneously. This house designed to be retrofitted to an existing house that is already slightly elevated off the ground and supported on short piers. Due to this, house can be remain close to the ground and retain its original appearance under normal circumstances, but to rise with water and float on its surface when flooding occurs, then Settle back in to its original position as the water level decreases. Various materials can be used for the construction of this structure like light weight materials such as polystyrene, precast blocks made with ferrocement, movable rollers, prefabricated materials etc

The main advantage of idea is that it is an economical solution for flood mitigation. It prevents an ongoing inconvenience to residents as well as creating a significant impediment for the elderly and others with impaired mobility.

1.1 Living in Flood Prone Area

Over the last 17 years, 25000 people were killed during the flood affecting over 300 million people. Trading along the waterways had grown-up into town and cities as industries grew in the country. Water was the main source of transportation. Thus people started living near by the sources such that they can reduce the travelling cost. No doubt we all need a place to live which has low cost and nearby your job location. This is main reason why people are still live there. Secondly, If we see now they might have made improvements to their houses over the years and don't want to leave it.

This history is not only the reason why low-lying areas are over populated. This is largely because Private Construction Companies do not take full cost of building on cheap land which comes under flood zone. It costs very low budgets for construction. So the new homes are still being constructed near flood Prone Areas.



Fig -1: Kerala Flood 2018

Kerala is one of the best examples of most destructive flood conditions in Indian history where Kerala received heavy monsoon rainfall, which was about 75% more than the usual rain fall in Kerala, on the mid-evening of August 8, resulting in dams filling to capacity; in the first 24 hours of rainfall the state received 310 mm (12 in) of rain. It was the worst flood in Kerala in nearly a century. Over 483 people died, and 14 are missing and about a million people were evacuated. Almost all dams had been opened since the water level had risen close to overflow level due to heavy rainfall, flooding local low-lying areas.

1.2 Living on Water

Building on water is not a new method. People have lived for centuries; by elevating houses on piles, retrofitting boats and designing amphibious architecture. Now it is time for the people living in low-lying areas to adopt this new method for their own benefits. Water dwellings can be proved efficient in times of extreme flooding.

The cost of Amphibious House can be less than a house built on land. Living on and near water already exists in many countries but in India it is still a new concept. Amphibious House is one of the best answers for all the problems like dwelling in flood prone areas.



Fig -2: Boat House in Bangladesh

Bangladesh being a delta country is frequently affected by flood. Millions are displaced and many lives are lost during severe floods due to overflowing of rivers, inadequate drainage and monsoon rains in Bangladesh. Flood cause the most damage to the low income population who live in informal settlements throughout the urban center of the country. As the city population continues to grow access to adequate housing is denied to low income citizen forcing 3.5 million people to find shelters in slum and custom built house boats.



Fig -3: Boat House in Kerala

House boats in Kerala are huge slow moving barges used for leisure trips. They are used to carry rice and spices from different places in early times. These house boats are considered as a convenient means of transportation. It is about 60 to 70 feet long and about 15 feet wide at the middle. The hull is made of wooden planks that are held tightly by ropes and coconut fiber. The roof is made up of bamboo poles and palm leaves. The exterior of the boat is painted with protective cashew nut oil coat. The need for housing brought many workers to transform old fishing boats into residential dwellings.

2. AMPHIBIOUS HOUSE

The Amphibious homes are under normal circumstances rest on concrete foundation and also starts floating when the water level rises and also during flooding. The advantage of these homes is that they are more or less like ordinary homes with parking space, a garden and access from road. The inhabitant feels that the house is floating only during flood conditions. Two houses are kept in place by the support of two mooring poles. These steel columns are driven deep into the ground. Even in the extreme flood condition the structure will be in place and can withstand the current of flowing water with help of these steel columns. These steel columns are connected by steel framework.

2.1 Objectives

The goal of this study is to explore how important Amphibious Architecture to coastal and riverside areas. Its objectives include how to overcome the difficulties with floods and rising sea water. To discover whether Amphibious Architecture is suitable method for India. To ensure the safety of life and protection from flood. Sustainable and affordable way of achieving Amphibious Architecture for India. To achieve the amphibious housing for low income group. Common people should understand the cause and effect of climate change and how to overcome the change. To change our current understanding towards floating building. The proposal for this dissertation will provide sustainable housing for the people of India to create permanent amphibious structure protected from flood.

2.2 Amphibious Architecture

Amphibious architecture is a sustainable flood mitigation strategy that allows an ordinary structure to float on the surface of rising floodwater rather than succumb to inundation. A buoyancy system beneath the house displaces water to provide flotation as needed, and a vertical guidance system allows the rising and falling house to return to exactly the same place upon descent. Amphibious architecture is a flood mitigation strategy that works in synchrony with a flood prone region's natural cycles of flooding, rather than attempting to obstruct them.



Fig -4: Architectural view of Amphibious House

Amphibious design also includes the concepts of land use planning, site selection, policy considerations and community resilience issues such as the place of amphibious buildings in multiple-lines-of-defense systems. Amphibious engineering addresses issues such as infrastructure, mechanical systems and utilities, system components and selection criteria, and codification and certification concerns.

2.3 Amphibious Construction

The common way to achieve the floating concept is making a hull and building a light weight house on top of it. This concept is used in all houseboats where steel or a timber hull will be used as a basis to build a house. A concrete hull which acts as a basement is adapted in these houses. Watertight 23 centimeter thick concrete hull was prefabricated and later moved to its location. The weight of concrete hull was about 70 tons and the timber house was about 22 tons. The concrete hull is resting on six concrete foundation pile.

A buoyant foundation is a type of amphibious foundation that is specially designed to be retrofitted to an existing south Louisiana shotgun house. It allows the house to sit just above the ground like a normal elevated house under normal conditions, but to rise up and float safely on the water when there is a flood. It has a structural sub frame that attaches to the underside of the house and supports the flotation elements, or buoyancy blocks. Extensions of the structural sub frame attach to the tops of vertical guidance poles near the corners of the house that telescope out of the ground to provide resistance to lateral forces from wind and flowing water. When flooding occurs, the flotation blocks lift the house, with the structural sub frame transferring the forces between the house, blocks and poles. The vertical guidance poles keep the house from going anywhere except straight up and down on top of the water.



Fig -5: The Float House, New Orleans



Fig -6: Interior Guide Poles and Sleeve Details

2.4 Comparison with Conventional Flood-proof House

There are many appealing factors that encourage homeowners and developers to opt for prefabricated housing rather than traditional construction. A significant factor in many circumstances is the relative low cost of prefabricated construction. While the scope of prefabricated homes ranges from mobile homes to very sizeable permanent housing, the reduction of on-site labour in most cases greatly reduces the cost of building a new house. In remote locations, where labour is sparse and/or expensive, pre-manufactured houses allow the construction of a house to take place by fewer individuals who only require a general understanding of foundations and assembly instructions, rather than bringing in various tradesmen from surrounding cities.

As compared to conventional housing construction process, the majority of the construction process of amphibious home takes place in a factory. In case of amphibious housing, it is not at the mercy of factors such as seasonal climates or weather conditions, which frequently delay the completion of projects. Also, since many of these houses are mass-manufactured models, whether for panelized structures or manufactured homes, often a substantial part, if not the entire manufactured product will already have been constructed even before it is purchased, allowing the transportation and/or assembly of the product to begin immediately.

2.5 Advantages and Limitations

The major advantage of Float house is that the residents can stay in home during flood. Buoyant foundation project has proved it can withstand extreme flooding by fitting the EPS block to the existing house. Low density but it gives high strength. It will not break down so it will not spread into surrounding soil. It can be installed by hand using simple tools so this eliminates the investment and operation costs of heavy machinery. Geofom is quick to install and can be installed during any type of weather. The LIFT house has proved low cost amphibious homes for Bangladesh people. Using of low cost material and locally available material can improve the vernacular character of the place and also efficiency of the structure.

Some of its limitations are as follows- This cannot be constructed as a multistoried building. Also, it is subjected to strong external loadings due to wind, rain, ice and other environmental conditions. There are restrictions to esthetic view as there is limitations of size and shape of the house. Along with this, height limitations are restricted to the mooring post height. Untreated geofom is easily affected by fire. If geofom comes in contact with a petroleum solvent it will immediately turn into glue type substances, making it

unable to support any load. Force developed because of buoyancy can result in a dangerous uplift force. Geofom should be treated to resist insect infestation. Insects like ants can burrow into the geofom and will weaken the material.

3. CONCLUSIONS

Amphibious buildings are proven low impact flood protection strategy that gives a community enhanced flood resilience and improves its ability to recover from disaster. When flooding occurs the water dwelling vertically rises with the water levels to remain safely above water then settles back into places as the water recedes. Successful amphibious foundation systems are functioning in the Netherland, New Orleans, Sausalito and Bangladesh, they can provide flood protection that is more reliable and more convenient than the permanent static elevations.

Amphibious construction, though not a new concept, has been growing in popularity over the past decade. The implementation of buoyant foundations as both retrofit and new construction could provide benefit to communities at high risk of chronic flooding, from applications in New Orleans' Lower Ninth Ward to slums in Bangladesh, and elsewhere around the world. Amphibious construction is a low-impact hurricane mitigation strategy that provides flood protection without increasing exposure to strong winds. It is an innovative approach that is rapidly gaining acceptance and finding application around the globe.

Amphibious foundations are a proven, low-cost, low-impact flood protection strategy that can increase a flood-prone community's resilience in the face of disaster. This low-impact technology thus provides houses with an even greater resilience to rising flood levels than PSE, without increasing the exposure of the structure to the more regularly occurring strong winds.

The long term view that is necessary in taking account of climate change also enables us to view other issues with the same horizon of opportunity facilitating new solution to spatial planning and the location of settlements, best practice in building design, infrastructure development and environmental flood defense. Therefore, it is time to evolve a new relationship with water to ask what is possible of design and construction and begin to look toward a flooded future with confidence and imagination.

REFERENCES

- [1] English E., "Amphibious Foundations and the buoyant foundation project: Innovative Strategies for Flood-resilient Housing," a paper presented at the Road Map Towards a Flood Resilient Urban Environment International Conference on Urban Flood Management, 25-27 November 2009, Paris, France.

- [2] Sandhya K. (Reg. no.313012251023) April 2016, "Amphibious Architecture in India," Da Vinci School of Design and Architecture, Karapakkam, Chennai.
- [3] Elisabeth English, Natasha Klink and Scott Turner, "Thriving with water: Developments in Amphibious Architecture in North America," School of Architecture, University of Waterloo, Canada, FLOODrisk 2016- 3rd European Conferences on Flood Risk Management, E3S Web of Conferences.
- [4] ICAADE 2015, First International Conference on Amphibious Architecture, Design and Engineering, Bangkok, Thailand, 26-29 August 2015. <http://icaade2015.wixsite.com/icaade-2015>
- [5] Buoyant Foundation Project, Inc. www.buoyantfoundation.org
- [6] Mohamad Ibrahim Mohamad, Mohammad Ali Nekooie, Zulhilmi Bin Ismail and Roohollah Taherkhani, "Amphibious Urbanization as a Sustainable Flood Mitigation Strategy in South-East Asia," Advanced Materials Research, Vols. 622-623, pp. 1696-1700, 2013.
- [7] Case study of 'The Thames Amphibious House'. www.construction21.org

BIOGRAPHIES



Tejas Urkude
Pursuing B.E. in Civil Engineering
D. Y. Patil College of Engineering,
Akurdi.



Amarchand Kumar
Pursuing B.E. in Civil Engineering
D. Y. Patil College of Engineering,
Akurdi.
Email-



Apoorva Upadhye
Pursuing B.E. in Civil Engineering
D. Y. Patil College of Engineering,
Akurdi.
Email-



Madhura Padwal
Pursuing B.E. in Civil Engineering
D. Y. Patil College of Engineering,
Akurdi.
Email-